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Comparison of Modelled Soil Moisture Drought of Two Land Surface Models

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Drought early warning is of high importance in the context of prevention of damage to agricultural crops, and related effects on food security.
Land surface models (LSMs) can be used to predict drought when combined with weather and climate forecasting systems. However, the underlying biophysical equations, and related model configurations, of land surface models will affect the models' prediction of the water, energy and carbon balance, and hence modelled indices of agricultural drought, such as those related to soil moisture content. Here, we explored the underlying formulations of two LSMs, with emphasis on their different soil hydraulic parameter (HP) configurations: CHTESSEL (Van Genuchten-Mualem HP), CTESSEL (Van Genuchten-Mualem HP), JULES (van Genuchten-Mualem HP), and JULES (Brooks and Corey HP) and canopy exchange and plant water stress configurations. The models were driven with WFDEI meteorological forcing data set for 1979 to 2012. Soil and vegetation ancillary data for CH/CTESSEL were obtained from soil maps based on FAO/UNESCO Digital Soil Map of the World and GLCC data set respectively. The JULES model soil map was based on a combination of FAO, HWSO and IGBP soil data; and the vegetation map was based on MODIS.
Several large domains in Europe were selected to cover most of the continent: UK, France, Spain, Scandinavia, Germany, Russia, Eastern Europe and Southern Europe. The models key variables and fluxes were compared to several observed datasets such as JENA-BGI, ERA-Interim/Land, SMOS, H27, GlobTemperature and GLEAM. A Soil Moisture Drought Index (SMDI) was calculated for the models and compared to a Vegetation Health Index dataset based on MODIS products. SMDI, along with the modeled plant water stress, were analysed to explore the models' ability in (historical) prediction of agricultural drought.
It was found that soil hydraulic parameters are primarily responsible for the difference between the behaviour of the two models during drought. The remaining difference between the models can be explained by the soil maps, phenology and treatment of water stress.